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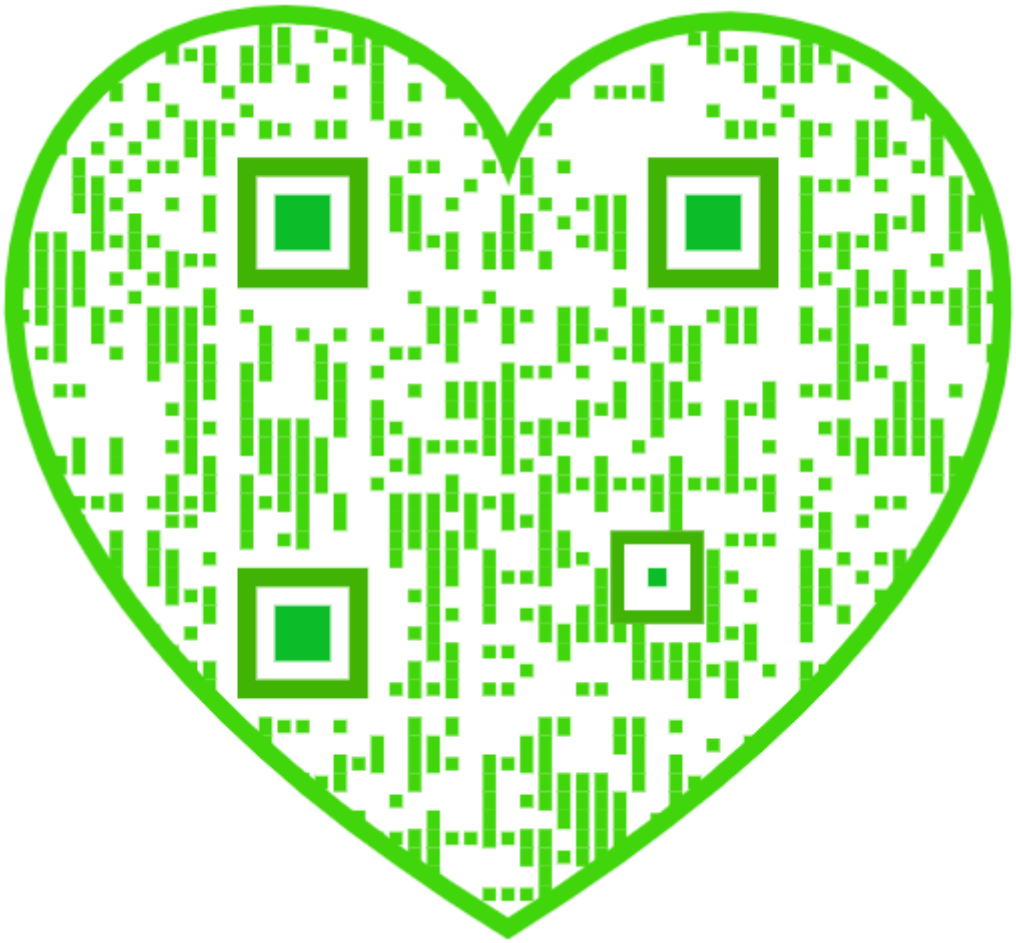

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[APPENDIX 5.—EXTRACTED FROM THE REPORT OF THE U. S. COMMISSIONER OF FISH AND FISHERIES FOR 1893. Pages 387 to 392.]

ESTABLISHMENT OF STATIONS

FOR THE

MAY 2 1896

PROPAGATION OF SALMON ON THE PACIFIC COAST.

BY

JOHN J. BRICE,
COMMANDER, UNITED STATES NAVY.

WASHINGTON:
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5.—ESTABLISHMENT OF STATIONS FOR THE PROPAGATION OF SALMON ON THE PACIFIC COAST.

By J. J. Brice, *Commander, United States Navy.*

Washington, D. C., *November 15, 1892.*

Sir: I have the honor to submit herewith a report of investigations and operations on the Pacific Coast in reference to the establishment of stations for the propagation of salmon.

The salmon, which formerly inhabited the Pacific Coast waters in countless millions, extending from Alaska to Monterey, are becoming each year more reduced in numbers in the yearly run, and the question resolves itself into one of almost final extinction or prompt and active measures for their protection and propagation. The importance of speedily furnishing a supply equal to the demand by artificial means is emphasized in the value of the fish industry on that coast, amounting to something like $7,000,000 yearly.

The seal fisheries are a national question and the most prominent subject before the people, verging on war, yet their actual commercial value is not so great as the fish industry on the Pacific, which is gradually slipping away from us through depletion by indifference and improvident destruction. The ruin has continued without interruption until some of the streams, formerly alive with fish, are now nearly exhausted and becoming as destitute of salmon as the Hudson and the other eastern rivers which were, in early times, abundantly stocked with many species of *Salmonidæ*. This destruction took place before artificial propagation was practiced, an excuse for that day and time; but it also serves as a warning in the present, with our knowledge of artificial means, to protect and guard the Pacific Coast streams from the same misfortune.

To formulate a plan to restore the salmon in their original numbers to the various streams on that coast and offset the yearly catch by artificial propagation has been my duty.

The urgent necessity for speedy action is manifest in the fact that there are many obstacles in the way of the rehabilitation of a river once depleted of its fish, aside from the great increase in the labor and the expense of transporting young fry from remote localities. It was therefore recommended to the United States Fish Commission to establish hatcheries on military or other Government reservations, and

similar desirable localities for the production of the different species of salmon, so arranged as to benefit all the streams on the Pacific Coast.

As an experimental effort and the commencement of the system, a hatchery was established at Fort Gaston, Humboldt County, Cal. This is the central hatchery, and has auxiliary or subhatcheries on the neighboring streams which empty directly into the ocean. These auxiliary hatcheries are used for taking the spawn and depositing the young fry on or near the spawning-grounds, and are kept open only during the spawning and hatching season, which would be about four months of the year. Besides the auxiliary station at Redwood River, it is proposed to connect with the Gaston Station two others on the Mad and Eel rivers. There are other streams near by which could be utilized in the same way, all emptying into the sea. In addition to stocking the waters of the Pacific with salmon and other indigenous fish, the central hatchery at Gaston is provided with ponds used for hatching and propagating eastern and foreign fish, such as landlocked salmon, eastern and German trout. Breeding ponds are in use, filled with the two last-mentioned fish, from which many will be distributed in the streams and waters throughout the country.

Other localities have been examined and suitable places inspected for hatcheries, those on the Colville Reservation near the head of the Columbia River and another at Lake Cœur d'Alene being particularly favorable. Military or Government reservations were selected for several reasons, prominent among them being the assured protection of the young fish. For convenience it is also desirable that the hatcheries should be located near the heads of the streams in the vicinity of the spawning-grounds, where fish are more likely to be found ripe and ready for stripping of their eggs. While the system need not be confined to Government reservations, such localities are preferable where facilities for the work meet with the requirements.

The streams should be stocked from the several varieties found on the Pacific Coast, preferably the indigenous or the kind of salmon which visit the particular stream. Great danger attends the introduction in any stream of fish not belonging to the waters. A stronger and more rapacious strange fish is sure to destroy the weaker native occupants of the stream, and give in return for the destruction probably an inferior and less prolific salmon.

The waters in Humboldt County, Cal., are also free from vagrant and predatory fish; consequently the young can be placed in the stream at an early age without molestation except from the trout which inhabit all these waters. The yearling trout is the voracious enemy of the young salmon, and being small himself is capable of pursuing the little fish into shoal water, their haven of refuge from danger. The destruction of salmon fry by these active young trout is very great. Therefore it is not policy to stock the same stream with both salmon and trout. Since there is no comparison in their commercial value

there should be no question as to which should receive the attention and protection of the Fish Commission. The Fort Gaston station is on the Trinity River, a tributary to the Klamath. The fish appear here early in the winter months and again in the spring to spawn.

When the salmon enters the river and commences his long journey to the spawning-grounds it is truly the effort of his life, resulting in many cases in death from accident or exhaustion. During this time he eats nothing, a wise provision of nature, otherwise the spawn, which is the most attractive food for fish, would be consumed by the multitudes which throng the streams during the spawning season. The salmon enter the river in good condition, well fortified with fat, upon which they maintain their strength, combined with the constant supply of nutriment from the destruction of the oil-bearing tissues which envelop the ovary and the outside membrane covering, the latter holding the eggs and oily essence surrounding them. Disintegration of the ovary adjuncts and spermatic parts begins shortly after the fish enter the river, in both male and female, but the supply is not so great in the former, because the burden and exertion are less.

The conjunction of natural causes in assisting the salmon in all his movements and in the manner of depositing the eggs is as interesting as it is beautiful. In the operation of spawning, from my own observation, the salmon on arriving at the place selected remains quiet until recovered from the effects of the long journey from the sea, and for this purpose they select a pool where there is protection and concealment, under driftwood or an overhanging bank. In pairs, male and female, they build their nests generally in the swift water on the ripple above or below the pool, the male guarding it with great jealousy by fighting away all intruders. The pool serves as a place of concealment during the day; the spawning and nest-making takes place at night or early in the morning, continuing during the daytime if it is overcast and dark. The act of spawning by the female may go on at intervals for a week before all the eggs are deposited.

The construction of the nest is commenced by digging an elongated hole, extending up and down the stream, and located in the swift water above or below the pool, the fish using the nose and fins in making the excavation, throwing out the sand and gravel in volumes in their effort. The stones and gravel are carried just below the excavation by the current, forming a nest covering a space sometimes more than 6 feet in diameter, the small particles of sand and dirt being carried far down the stream.

It seems strange that a collection of stones and pebbles should form a fish nest, and it becomes a matter of speculation as to the manner of secreting the eggs under a mass of stones. Yet nature has made it very simple, and secured its results in a matter-of-fact way. The eggs are deposited in the hole by the female and impregnated by the male. During the fertilization, which takes from half an hour to fifty minutes,

the eggs cling together in a mass and to the bottom of the stream; they then commence to separate, and the gentle current sweeping down through the trough-like hole carries the egg out of the excavation, as it becomes detached from the mass, and onto the nest of stones below, where it tumbles from one stone to another, until it drops into one of the crevices, eventually finding its way to the bottom of the pile or nest, and there lies securely hidden away, well protected from predatory fish, until it is finally hatched.

It takes from forty to sixty days for the eggs to hatch, the time depending upon the temperature of the water. After hatching the fish remain in the nest about twenty days, until the umbilical sac is exhausted, having at this time but one instinct—to hide and burrow deeper into the nest. After the substance of the sac is consumed the little fish approaches the surface to snap at passing particles of food, and in so doing is washed away from the nest and finally makes its way to the shoal water near the shore, gradually dropping downstream until the fall freshets come and carry it into the larger streams, and eventually into the ocean.

Salmon make their nests and spawn differently under different circumstances. If prevented from reaching their spawning-ground, by late freshets or other obstacles, they will spawn in the river or deposit their eggs in the muddy bottom of a pool, if there are no gravel beds available. In both instances most of the eggs are lost. By artificial means as much as 95 per cent of the eggs are hatched; and in depositing the young fry it has been the custom at the Fort Gaston station to place them in the streams near the spawning-grounds five or six weeks after hatching. Young salmon fed abundantly in the ponds for four or five months before they are put in the streams acquire different habits, and are inclined to linger in the fresh water the year round, having become too strong to be carried out by the fall and winter freshets against their inclination. The salmon is very much the victim of circumstances, and in his movements is governed more or less by freshets and the temperature of the water. From the latter he is most naturally controlled in seeking more genial surroundings. The early stage of a little salmon's existence is made up of continuous alarms to avoid danger, and the commencement of his life is spent in hiding and darting about until he gains sufficient strength and activity to venture abroad for food, trusting to speed for safety.

The method of taking salmon for spawn at Fort Gaston consists in running a wire fence diagonally across the stream, near the upper end of which is inserted a V-shaped trap made of the same wire stretched over a wooden frame; the pointed end of the trap is placed upstream and the wire fence extends to the shores from each corner of the lower end. In the lower face of the trap is a hole large enough for the salmon to enter, with converging steel rods, 18 inches long, extending inwardly from around the opening; these are pressed apart as the salmon enters and spring

back into place when he is secure inside. The traps are located below the spawning-ground and convenient to the hatchery.

The Fort Gaston station was the experimental attempt in the commencement of a systematic plan to stock yearly the streams on the Pacific with salmon, and in view of the satisfactory results given by this station it is recommended that the system be extended by establishing hatcheries with 4 auxiliary stations each in the following localities: One on the Chilcat River, in Alaska, or in its vicinity; one on Puget Sound; one on the Colville Reservation, Columbia River, and one on Eel River, California. It is also recommended to increase the Gaston station with 3 auxiliary hatcheries, and connect with the McCloud station 4 auxiliary stations.

The following is an estimate of the cost of establishing and maintaining these proposed stations:

Four central hatcheries, buildings, and apparatus, at $2,000	$8,000
Twenty auxiliary hatcheries, at $300 each	6,000
Five superintendents, at $1,200 per year each	6,000
Six laborers, at $40 per month each for twelve months	2,880
Twenty-four laborers, at $40 per month each for four months	3,840
Yearly miscellaneous expenses of each central hatchery, including its auxiliary stations	1,500
Total miscellaneous expenses yearly of five stations, not including the McCloud hatchery	7,500

With this small outlay of public money each important salmon stream on the Pacific Coast could be stocked with young fish artificially hatched far exceeding in numbers the yearly catch or market demand.

As the farmer recognizes the necessity of replenishing his stock every year, in like manner the same prudent forethought is required in regard to the occupants of the streams, and the expenditures for this purpose in the plan suggested are insignificant when compared to the millions of dollars represented in the result.

For the further protection of the fish on that coast, it is suggested that one of the rivers, the Klamath, for instance, and its tributaries, be held by the Government as a fish preserve, prohibiting seining or taking salmon in any way for commercial purposes. A great national nursery would thereby be established, from which not only the Pacific Coast would be benefited, but the whole country. The land extending some distance from the mouth of the Klamath River is, I believe, a Government reservation, requiring no special legislation to close the stream to outside enterprise.

Authorities give the salmon (genus *Oncorhynchus*) on the Pacific Coast as representing five species. The king, quinnat, or chinook salmon has an average weight of 22 pounds; there are 16 rays on the anal fin to distinguish it. The blueback salmon weighs from 5 to 8 pounds and has 14 to 16 rays on its anal fin. The silver salmon, weighing from 3 to 8 pounds, has 13 rays on the anal fin to distinguish it. The dog salmon, with an average weight of 12 pounds, has 14 anal rays. In the fall the

male dog salmon is red and his jaws are much distorted. This is also true of the humpback salmon, which is small, weighing up to 6 pounds and having 15 anal rays.

Among the offshoots of the *Salmonidæ* is the steelhead, which, from good authority, is the salmon trout, the same species as the rainbow trout in the streams. In point of fact the steelhead and rainbow trout were originally one and the same fish, so far as at present known from their construction, the difference in size being due to their habits and the extensive surroundings of the steelhead. In construction, except its size, the steelhead is a trout, but in habits a salmon. The rainbow trout may become a salmon trout (or steelhead) when its habits are anadromous, which could occur through accident, such as an unusual freshet in which the rainbow trout is washed into the estuaries of the rivers and the sea. The rich food and boundless extent of territory off the mouths of rivers account for his increase in size and strength. This growth is noticed in the salmon as being comparatively insignificant while remaining in fresh water, but rapid upon its first visit to the sea. Fish food is most plentiful in the ocean near the estuaries of the rivers, as the influence of the fresh-water stream is felt many miles at sea, causing an abundant growth of marine vegetation or vast pastures, attracting the smaller fish and crustacea upon which the salmon feed, returning yearly to their native rivers to spawn.

Very respectfully,

J. J. BRICE,
Commander, U. S. Navy.

Hon. MARSHALL MCDONALD,
United States Fish Commissioner.

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